GR-LEON4-ITX Development Board

Quick Start Guide

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REVISION HISTORY

Revision	Date	Page	Description
0.1	2010-03-17	All	New document
0.2	2010-06-16	29, 30, 32	Fixed minor errors and omissions in U-boot image creation. Added information on how to change the EDCL IP address used by U-boot.
0.3	2013-03-05	9, 12, 21, 28 - 30	Add note about lack of RS232 transceiver on DSU UART connector. Add note stating that the SnapGear distribution is no longer maintained and that new users can be better of with LinuxBuild. Add information on Linux SMP booting with MKPROM2 and limitations of U-boot.

1 INTRODUCTION

1.1 Overview

This document is a quick start guide for the *GR-LEON4-ITX* Development Board.

The purpose of this document is to get users quickly started using the board. For a complete description of the board please refer to the *GR-LEON4-ITX Development Board User Manual*, the LEON4 system-on-chip is described in the *LEON4-ASIC-DEMO Data sheet and User's Manual*. This quick start guide does not contain as much technical details and is instead how-to oriented. However, to make the most of the guide the user should have glanced through the two aforementioned documents and should ideally also be familiar with the GRMON debug monitor.

The GR-LEON4-ITX data package and this document (including possibly newer revisions) are available from the GR-LEON4-ITX product page at http://www.gaisler.com

1.2 References

RD-1	LEON4-ASIC-DEMO Data sheet and User's Manual, Aeroflex Gaisler, 2010
RD-2	GR-LEON4-ITX Development Board User Manual, Aeroflex Gaisler, 2010
RD-3	GRMON User Manual
RD-4	SnapGear Linux for LEON

The referenced documents can be downloaded from http://www.gaisler.com or be found on the USB Flash stick accompanying the board.

1.3 Abbreviations

ASIC	Application Specific Integrated Circuit.
DIL	Dual In-Line
DDR	Double Data Rate
DSU	Debug Support Unit
GPIO	General Purpose Input / Output
I/O	Input/Output
I^2C	IIC, Inter integrated circuit, a 2 wire bus
IP	Intellectual Property
MUX	Multiplexer
PCB	Printed Circuit Board
RMII	Reduced Media Independent Interface
SOC	System On a Chip
SPI	Serial Peripheral Interface

2 UNPACKING AND SETTING UP THE BOARD

2.1 Unpacking and initial setup

The board is delivered with a power supply, JTAG adapter, USB and Ethernet cables.

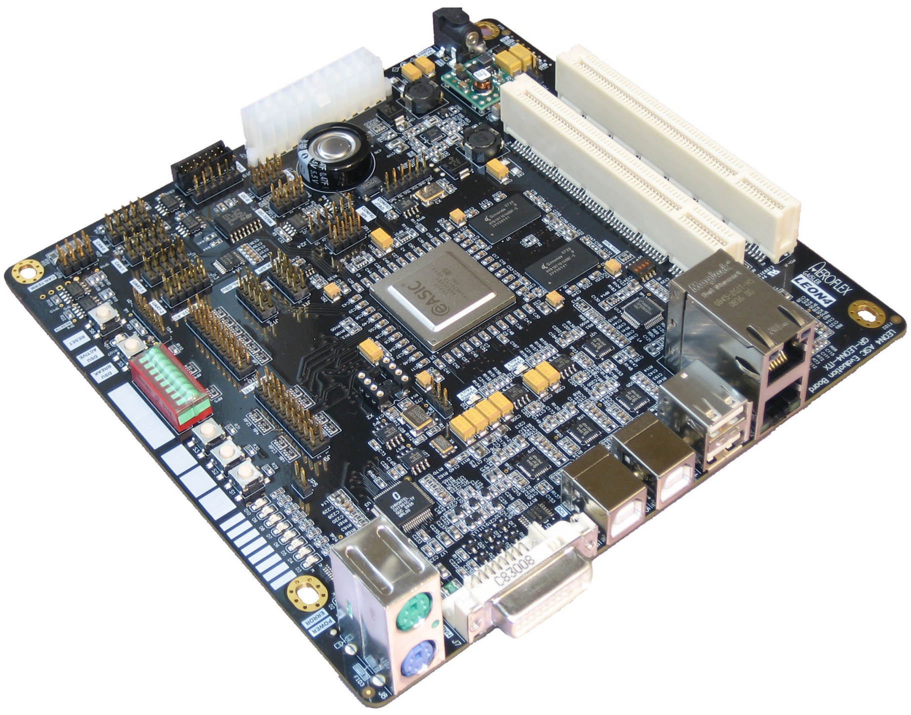


Figure 2-1: GR-LEON4-ITX Development Board

After unpacking the board, two routes can be taken. Either the preprogrammed Linux system can be booted, or you can connect to the board using the GRMON debug monitor. If you wish to start the bundled Linux system, please proceed to section 2.2 , to work with the board through the GRMON debug monitor skip to section 2.3 .

2.2 Running the bundled Linux system

Overview

The GR-LEON4-ITX board's SPI boot PROM has been programmed with boot loader that loads an image of the Linux kernel into main memory and then boots the kernel. The Linux kernel then mounts its root file system, containing initialization scripts and software, from a USB Flash stick. The Linux console is available both over the DVI video interface and over the serial terminal.

Pre-requisites

The Linux kernel mounts the root filesystem from the USB stick included in the delivery. Therefore the USB stick must be attached to the board. As previously stated, the Linux console is available both over the video interface and over the serial terminal. As the board only provides PIN headers with the receive and transmit lines for the serial terminal it is recommended that a monitor, keyboard and mouse is attached to the board. According the normal conventions for the PS/2 interface, the top connector (green) is the Mouse interface and the bottom connector (purple) is the Keyboard interface. If using a USB keyboard and mouse the devices should be connected via a USB hub and the USB memory stick should be directly connected to one of the board's USB ports.

The connected monitor must support DVI-A output, the board can also be connected to a monitor using a DVI-to-VGA adapter.

It is recommended, but not required, to connect the board to a Ethernet network where it can receive an IP address via DHCP and access the Internet. This will allow system software to automatically set the system date and time. If an Ethernet cable is attached it should be connected to the first Ethernet port (the lower port).

Booting Linux

The bootloader will start Linux when the power adapter is attached to the board. Please skip to section 3 for usage instructions. Section 5.1 contains transcripts of the output that should be shown on the monitor during the boot process.

2.3 Connecting with the GRMON debug monitor

Overview

GRMON is a competent debug monitor that is used to debug GRLIB/LEON systems. The GR-LEON4-ITX board has a number of debug interfaces that are all supported by GRMON.

Note: If you intend to use GRMON to work with the board it is recommended to clear the SPI boot PROM as described in section 4.5 .

Pre-requisites

The board is delivered with a JTAG adapter that can be used to connect to the board. For a description of how to set up the JTAG device, or for other JTAG adapters please see the *GRMON User's Manual*. The documentation and a evaluation version of GRMON is available from http://www.gaisler.com. Unless you will be loading software that will use the USB Flash stick, it is recommended to not connect the USB Flash stick to the board.

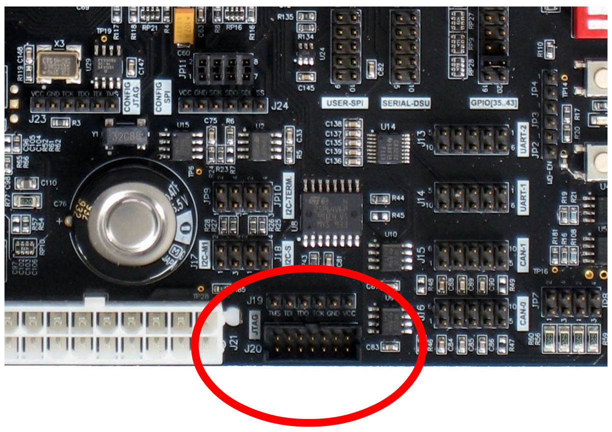


Figure 2-2: User JTAG headers

Connecting with the included JTAG adapter

The JTAG adapter shall be connected to the board using the JTAG pin header shown in the middle bottom of Figure 2-2. Please ensure that the JTAG cable/adapter is connected with the correct polarity, to prevent unintended damage to the board or cable.

To connect to the board using the JTAG adapter delivered with the board, issue the command:

```
grmon -jtag
```

Connecting with a Xilinx USB JTAG adapter

The JTAG adapter shall be connected to the board using the JTAG pin header, or ribbon connector, shown in the middle bottom of Figure 2-2. Please ensure that the JTAG cable/adapter is connected with the correct polarity, to prevent unintended damage to the board or cable.

To connect to the board using a Xilinx USB adapter, issue the command:

```
grmon -xilusb
```

Connecting via the USB interface

Please see the GRMON User's Manual for how to set up the required USB driver software. Then connect to the board using the command:

```
grmon -usb
```

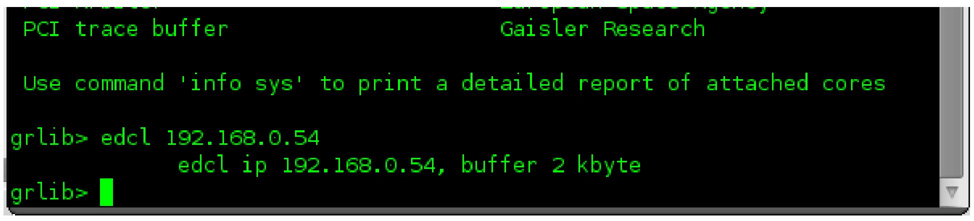
Connecting via serial UART

Please refer to the *GR-LEON4-ITX Development Board User Manual* and the *GRMON User's Manual* for instructions on how to connect via the serial debug interface.

NOTE: The DSU UART interface does not have a RS232 transceiver mounted on the board! See user board user manual for instructions.

Connecting via Ethernet

Before connecting via Ethernet the host computer (the computer running GRMON) must be connected to the same network as the GR-LEON4-ITX board. After that the IP address of the Ethernet Debug Communication Link (EDCL) must be set up. This address can be set up either by PROM software or by using another debug link. After connecting with an alternate debug link, issue the command *edcl <ip address>.* Figure 2-3 below shows a session where an IP address is set and the expected output:



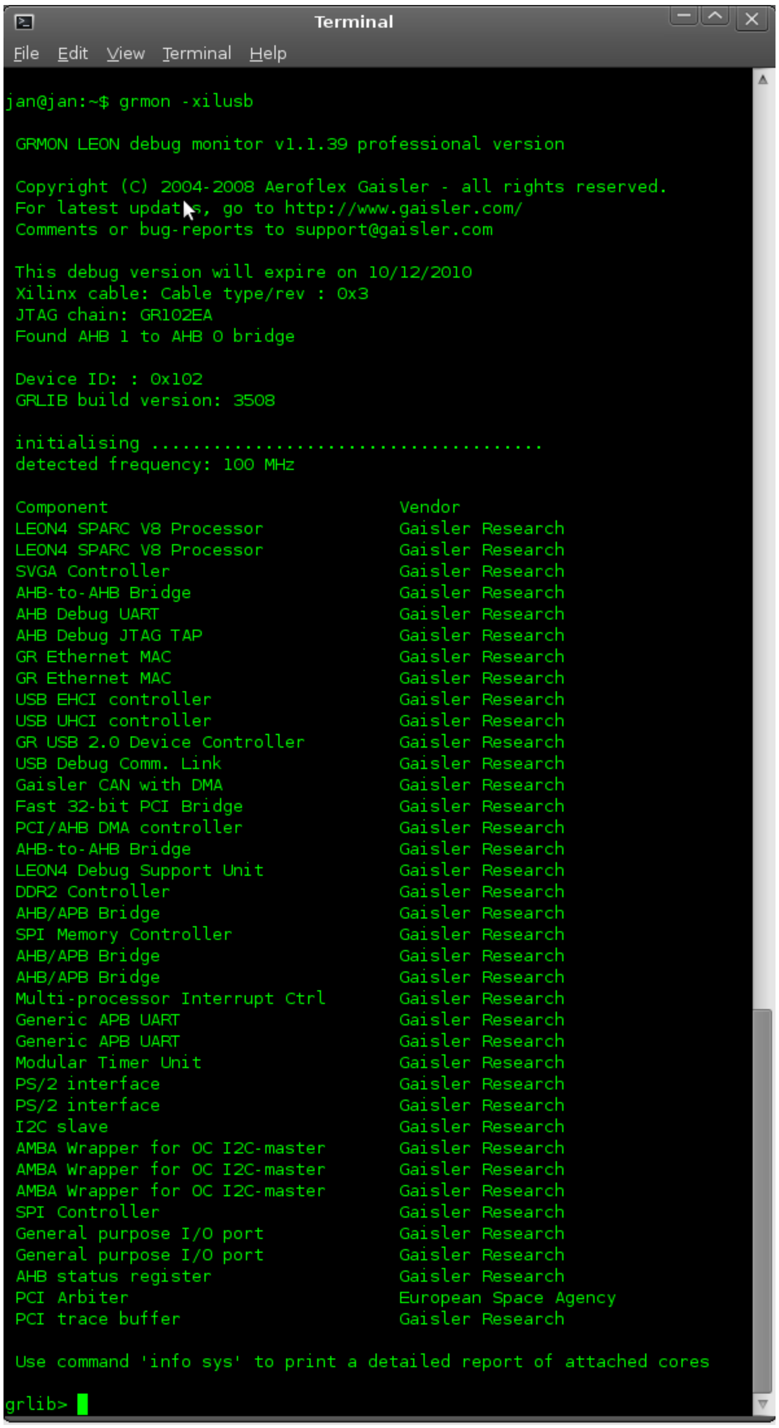
```
 PCI trace buffer                       Gaisler Research

 Use command 'info sys' to print a detailed report of attached cores

grlib> edcl 192.168.0.54
             edcl ip 192.168.0.54, buffer 2 kbyte
grlib> 
```

Figure 2-3: Setting the EDCL IP address

After the EDCL IP address has been set, connect to the target with

```
grmon -eth -ip <ip address>
```

In the example above, the command would be: `grmon -eth -ip 192.168.0.54`



```
jan@jan:~$ grmon -xilusb

 GRMON LEON debug monitor v1.1.39 professional version

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 For latest updates, go to http://www.gaisler.com/
 Comments or bug-reports to support@gaisler.com

 This debug version will expire on 10/12/2010
 Xilinx cable: Cable type/rev : 0x3
 JTAG chain: GR102EA
 Found AHB 1 to AHB 0 bridge

 Device ID: : 0x102
 GRLIB build version: 3508

 initialising ......................................
 detected frequency: 100 MHz

 Component                            Vendor
 LEON4 SPARC V8 Processor             Gaisler Research
 LEON4 SPARC V8 Processor             Gaisler Research
 SVGA Controller                      Gaisler Research
 AHB-to-AHB Bridge                    Gaisler Research
 AHB Debug UART                       Gaisler Research
 AHB Debug JTAG TAP                   Gaisler Research
 GR Ethernet MAC                      Gaisler Research
 GR Ethernet MAC                      Gaisler Research
 USB EHCI controller                  Gaisler Research
 USB UHCI controller                  Gaisler Research
 GR USB 2.0 Device Controller         Gaisler Research
 USB Debug Comm. Link                 Gaisler Research
 Gaisler CAN with DMA                 Gaisler Research
 Fast 32-bit PCI Bridge               Gaisler Research
 PCI/AHB DMA controller               Gaisler Research
 AHB-to-AHB Bridge                    Gaisler Research
 LEON4 Debug Support Unit             Gaisler Research
 DDR2 Controller                      Gaisler Research
 AHB/APB Bridge                       Gaisler Research
 SPI Memory Controller                Gaisler Research
 AHB/APB Bridge                       Gaisler Research
 AHB/APB Bridge                       Gaisler Research
 Multi-processor Interrupt Ctrl       Gaisler Research
 Generic APB UART                     Gaisler Research
 Generic APB UART                     Gaisler Research
 Modular Timer Unit                   Gaisler Research
 PS/2 interface                       Gaisler Research
 PS/2 interface                       Gaisler Research
 I2C slave                            Gaisler Research
 AMBA Wrapper for OC I2C-master       Gaisler Research
 AMBA Wrapper for OC I2C-master       Gaisler Research
 AMBA Wrapper for OC I2C-master       Gaisler Research
 SPI Controller                       Gaisler Research
 General purpose I/O port             Gaisler Research
 General purpose I/O port             Gaisler Research
 AHB status register                  Gaisler Research
 PCI Arbiter                          European Space Agency
 PCI trace buffer                     Gaisler Research

 Use command 'info sys' to print a detailed report of attached cores

grlib>
```

Figure 2-4: GRMON after connect

Using GRMON

The *GRMON User's Manual* describes the capabilities of GRMON. Section 4 of this document describes some usage scenarios for GRMON on the GR-LEON4-ITX board.

3 LINUX SYSTEM USER GUIDE

3.1 Overview

When the system is powered on the processor will load the Linux kernel from flash into main memory. The kernel will then mount a Debian root file system system from the USB Flash stick.

The sections below describe the system and the available user interfaces. The reader is encouraged to read the full documentation before using the system for the first time.

NOTE: *The Linux image programmed into the board SPI Flash boot PROM and the source code provided on the USB stick is for SnapGear Linux. This is an older Linux distribution that is no longer actively maintained by Aeroflex Gaisler. For users that want to do Linux kernel development, and for applications that require a newer user land, or are better off using BusyBox, it is recommended to start from Aeroflex Gaisler's newer solution built around Linux, named LinuxBuild. Packages are available from http://www.gaisler.com.*

3.2 Debian Operating System

The USB Flash stick contains an installation of Debian 4.0 (Etch). Debian is a well-known GNU/Linux distribution which comes with extensive documentation and a large set of precompiled applications. A good starting point for Debian documentation is http://www.debian.org/doc/

Precompiled applications can easily be added using Debian's package management system. To search for an application the command apt-cache can be used. To search for the application `less', issue the command:

```
apt-cache search less
```

The output will show a large amount of packages, in this case the package we searched for is simply named less:

```
less - Pager program similar to more
```

To install this application we now issue (to install applications you must be logged in as the super-user):

```
apt-get install less
```

This will fetch the application from a public repository specified in the file */etc/apt/sources.list*, which at delivery is specified to a public repository that can be accessed over the Internet. More documentation about the package management system is available at the Debian website mentioned above.

3.3 Logging in to the system

There are three ways of logging in to the system,

- Serial terminal connected to the RS232 port (or GRMON with -u flag)
- Keyboard, mouse and computer screen directly attached the system

The recommended interface for system interaction is to attach a keyboard, a mouse and a computer monitor and use the command line interface. This setup will be no different from working with a normal Linux desktop system.

The serial terminal provides an alternative way of access. To access the system via the serial port the terminal emulator should be configured for 38400 8N1. The system boot messages will be displayed on the frame buffer device. The serial terminal will display a login prompt when the system has completed its boot process.

The system has two accounts for login:

Username	Password	Description
user	user	Normal user account.
root	root	Super-user account. Should only be used for system administration.

Table 3-1: System accounts

3.4 Shutting down the System

To protect the integrity of the file system, the system software should be properly shut down before powering down the board. The correctly shut down the system, issue the command:

```
shutdown -h now
```

This command must be issued as the super-user (root). After the system has reported that is going down for system halt there will be no more output on the serial terminal. The system will report *Halt* on the frame buffer console when it is safe to power-off the board. If an external screen is not connected, it can be assumed safe to power-off the system 90 seconds after the *The system is going down for system halt NOW!* message has been displayed on the serial terminal.

3.5 Graphical Interface (X Window System)

The X window system graphical interface can be started from the command line by using the command **startx**. This will launch a session using the BlackBox window manager, right-click on the mouse will bring up the menu.

Other window managers can be started by editing the *.xsession* file in the home directory (for the user account, */home/user/.xsession*). If the file is changed to *exec fvwm2,* **startx** will launch an X session using the FVWM window manager (http://www.fvwm.org).

The graphical interface has a menu option to shut down the system, but this is not supported by the hardware. Instead, X should be exited back to the shell before the system is shut down.

The X window system may show some instabilities, particularly when exiting the graphical interface. If this leads to the system being inaccessible from the keyboard and mouse it is typically still possible to connect to the system via another interface, such as the serial terminal or network.

3.6 Network Interface

The network interface is configured during system start-up with the information contained in the file */etc/network/interfaces*. The default content of this file is:

```
# The loopback network interface
auto lo
iface lo inet loopback

# The primary network interface
auto eth0
iface eth0 inet dhcp
```

To assign a static IP address the file contents could be changed to, for instance:

```
# The loopback network interface
auto lo
iface lo inet loopback

# The primary network interface
auto eth0
iface eth0 inet static
        address 192.168.0.58
        netmask 255.255.255.0
        network 192.168.0.0
        broadcast 192.168.0.255
        gateway 192.168.0.1
```

It is recommended that the system is attached to a network which allows access to the Internet.

3.7 System Time Keeping

System software that is currently delivered with the board does have support for reading out the board's real time clock and is therefore not able to keep the system time after the system has been shut down. To avoid problems, such as irregularities caused by file time stamps being in the future, it is strongly recommended that the system time is set at each boot. If the system is connected to a network this can be automated by configuring the software to set the time from a Network Time Protocol (NTP) server.

The delivered system is configured to set the time from the NTP server ntp1.chalmers.se. Another NTP server can be selected by editing the file */etc/default/ntpdate*.

If the board cannot be connected to a network with an NTP server, the time can be set manually with the commands:

```
date --set 2008-10-10
date --set 14:00:00
```

The commands must be run as the super-user (root) and this must be done each time the system has been restarted, unless the system has access to an NTP server.

3.8 Changing the Keyboard Layout

The system is configured to use a keyboard with a US American layout. If a keyboard with another layout is to be used the keymap should be changed. For the console keyboard layout issue the command below as the super-user (root):

```
dpkg-reconfigure console-data
```

In the package configuration, choose *Select keymap from full list*. The keymap that should be chosen is likely prefixed with *“pc /”.* The system is delivered with the setting:

```
pc / qwerty / US american / Standard / Standard
```

The keymap for the graphical X Window system will also need to be changed if a keyboard with a non-american layout is connected. This can be done by editing the */etc/X11/xorg.conf* file and modifying the line:

```
Option “XkbLayout”        “us”
```

To the layout choice corresponding to the new keyboard, for example by exchanging *“us”* to *“fr”*.

4 GRMON AND THE GR-LEON4-ITX BOARD

4.1 First steps

The subsections below assume that GRMON, the host computer and the GR-LEON4-ITX board have been set up so that GRMON can connect to the board. The transcripts with courier font below are from a shell session invoking the command line version of GRMON. The same commands can be used when the debugger is used with a GUI.

```
grmon -eth -ip 192.168.0.54

 GRMON LEON debug monitor v1.1.39 professional version

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 For latest updates, go to http://www.gaisler.com/

 Comments or bug-reports to support@gaisler.com

 ethernet startup. Found AHB 1 to AHB 0 bridge

 Device ID: : 0x102

 GRLIB build version: 3508

 initialising .....................................
 detected frequency: 100 MHz

 Component                            Vendor
 LEON4 SPARC V8 Processor             Gaisler Research
 LEON4 SPARC V8 Processor             Gaisler Research
 SVGA Controller                      Gaisler Research
 AHB-to-AHB Bridge                    Gaisler Research
 AHB Debug UART                       Gaisler Research
 AHB Debug JTAG TAP                   Gaisler Research
 GR Ethernet MAC                      Gaisler Research
 GR Ethernet MAC                      Gaisler Research
 USB EHCI controller                  Gaisler Research
 USB UHCI controller                  Gaisler Research
 GR USB 2.0 Device Controller         Gaisler Research
 USB Debug Comm. Link                 Gaisler Research
 Gaisler CAN with DMA                 Gaisler Research
 Fast 32-bit PCI Bridge               Gaisler Research
 PCI/AHB DMA controller               Gaisler Research
 AHB-to-AHB Bridge                    Gaisler Research
 LEON4 Debug Support Unit             Gaisler Research
 DDR2 Controller                      Gaisler Research
 AHB/APB Bridge                       Gaisler Research
 SPI Memory Controller                Gaisler Research
 AHB/APB Bridge                       Gaisler Research
 AHB/APB Bridge                       Gaisler Research
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 Generic APB UART                     Gaisler Research
 Modular Timer Unit                   Gaisler Research
 PS/2 interface                       Gaisler Research
 PS/2 interface                       Gaisler Research
 I2C slave                            Gaisler Research
 AMBA Wrapper for OC I2C-master       Gaisler Research
 AMBA Wrapper for OC I2C-master       Gaisler Research
 AMBA Wrapper for OC I2C-master       Gaisler Research
 SPI Controller                       Gaisler Research
 General purpose I/O port             Gaisler Research
 General purpose I/O port             Gaisler Research
 AHB status register                  Gaisler Research
 PCI Arbiter                          European Space Agency
 PCI trace buffer                     Gaisler Research

 Use command 'info sys' to print a detailed report of attached cores

grlib>
```

At this point GRMON has successfully connected to the system. In this case we used the

Ethernet Debug Communications Link (EDCL). However any of the other debug links would be fine. The first listing shows all cores available in the design. Giving the command *info sys* prints a detailed report of the system. The output is too long to include here, however as a sample with some most of the output cut out:

```
grlib> info sys

00.01:048   Gaisler Research  LEON4 SPARC V8 Processor (ver 0x0)
             ahb master 0
```

… some output removed...

```
02.01:01d   Gaisler Research  GR Ethernet MAC (ver 0x0)
             ahb master 2, irq 12
             apb: c0100100 – c0100200
             edcl ip 192.168.0.54, buffer 2 kbyte
```

… some output removed...

```
01.01:02e   Gaisler Research  DDR2 Controller (ver 0x0)
             ahb: 40000000 – 80000000
             ahb: ffe00100 – ffe00200
             32-bit DDR2 : 1 * 256 Mbyte @ 0x40000000
                          200 MHz, col 10, ref 7.8 us, trfc 135 ns
```

… some output removed...

```
grlib>
```

The above shows a sample of the cores connected. In the sample we can see that the EDCL IP address has been set and that the EDCL has 2 kbyte hardware buffer, we can also see that GRMON has identified, and configured the DDR2 controller to use, 256 MiB of DDR2 SDRAM memory.

4.2 Running an application

In this example we will compile and run an application of our own. The procedure for downloading other applications is the same as shown below.

In order to cross-compile a stand-alone C application the host computer must have the BCC toolchain installed. The toolchain can be downloaded from http://www.gaisler.com and is also included on the USB Flash stick (*software/toolchains/BCC*).

Below is a transcript of a terminal with comments inserted:

Show contents of file hello.c:

```
user@host:~$ cat hello.c

#include <stdio.h>
int main(void)
{
   printf("Hello world\n");

   return 0;
}
```

Compile and link application, place resulting machine code in file hello:

```
user@host:~$ sparc-elf-gcc -Wall hello.c -o hello
```

Connect with GRMON and load the application. Note that the flag -u is given to GRMON. This flag places the first UART in debug mode which means that GRMON will echo the characters written to the UART and the user does not need to attach a dedicated serial terminal to the board. Without -u switch, no output would come from the program. Please see the *GRMON User's Manual* for more information.

```
jan@jan:~$ grmon -eth -ip 192.168.0.54 -u
```

```
 GRMON LEON debug monitor v1.1.39 professional version
```

… output removed ….

```
 Use command 'info sys' to print a detailed report of attached cores
```

Download application to RAM:

```
grlib> load hello
section: .text at 0x40000000, size 39584 bytes
section: .data at 0x40009aa0, size 2764 bytes
total size: 42348 bytes (70.4 Mbit/s)
read 201 symbols
entry point: 0x40000000
```

Run the application that was just downloaded:

```
grlib> run
Hello world

Program exited normally.

grlib>
```

After this the application can be downloaded and run again. Please also try commands such as *inst* or *hist* after running an application and refer to the *GRMON User's Manual* for their meaning.

4.3 Initializing the DVI transmitter

The DVI transmitter on the board must be initialized before it can pass video data from the LEON4-ASIC-DEMO device to a monitor. There are several GRMON commands tailored for initializing the DVI transmitter with values suitable for the GR-LEON4-ITX board.

Command	Description
i2c 3 dvi init l4itx_dvi	Initialize the DVI transmitter for IDF 2 input data (16-bit color depth) and monitor connected via digital DVI.
i2c 3 dvi init l4itx_vga	Initialize the DVI transmitter for IDF 2 input data (16-bit color depth) and monitor connected via analog interface (or DVI-to-VGA adapter).
i2c 3 dvi init l4itx_dvi 0	Initialize the DVI transmitter for IDF 0 input data (24-bit color depth) and monitor connected via digital DVI.
i2c 3 dvi init l4itx_vga 0	Initialize the DVI transmitter for IDF 0 input data (24-bit color depth) and monitor connected via analog interface (or DVI-to-VGA adapter).

Table 4-1: GRMON DVI transmitter initialization

The transcript below shows the GRMON output:

```
grlib> i2c 3 dvi init_l4itx_dvi

 Transmitter was not set to Chrontel CH7301C (AS=0), changing..

 DVI transmitter set to Chrontel CH7301C (AS=0)

 Initializing CH7301 for LEON/GRLIB design..

 Initialization done..

grlib>
```

After initializing the transmitter, the command *i2c 3 dvi showreg* will show the values of the DVI transmitter's registers.

4.4 Drawing images

GRMON has support for drawing both test screens and images in PPM ASCII format. The transcript below show commands that draw the built-in test screen in different modes. Note that the DVI transmitter must be initialized for the correct bit depth.

```
grlib> i2c 3 dvi init_l4itx_dvi

 Transmitter was not set to Chrontel CH7301C (AS=0), changing..

 DVI transmitter set to Chrontel CH7301C (AS=0)

 Initializing CH7301 for LEON/GRLIB design..

 Initialization done..

grlib> svga formats

 Available SVGACTRL display formats:

        Format  Resolution, refresh rate
       ------  ------------------------
       0       480x272,
       1       480x240,
       2       640x480, 60 Hz
       3       640x480, 72 Hz
       4       640x480, 75 Hz
       5       640x480, 85 Hz
       6       800x480,
       7       800x600, 56 Hz
       8       800x600, 60 Hz
       9       800x600, 72 Hz
       10      800x600, 75 Hz
       11      800x600, 85 Hz
       12      1024x768, 60 Hz
       13      1024x768, 70 Hz
       14      1024x768, 75 Hz
       15      1024x768, 80 Hz
       16      Custom format (undefined)

grlib> svga draw test_screen 2 16

 Drawing picture = test_screen, Depth = 16 bits, Format = 640x480, 60 Hz
 Framebuffer memory pos = 0x40200000

grlib> svga draw test_screen 8 16

 Drawing picture = test_screen, Depth = 16 bits, Format = 800x600, 60 Hz
 Framebuffer memory pos = 0x40200000

grlib> svga draw test_screen 12 16

 Drawing picture = test_screen, Depth = 16 bits, Format = 1024x768, 60 Hz
 Framebuffer memory pos = 0x40200000

grlib> i2c 3 dvi init_l4itx_dvi 0

 Initializing CH7301 for LEON/GRLIB design..
 Initialization done..

grlib> svga draw test_screen 8 32

 Drawing picture = test_screen, Depth = 32 bits, Format = 800x600, 60 Hz
 Framebuffer memory pos = 0x40200000

grlib>
```

The test screen consists of a framed white cross on black background.

4.5 Interacting with the SPI boot PROM

GRMON provides support for interacting with SPI memory devices via its SPI Flash layer. SPI memory devices can be controlled both over SPICTRL and SPIMCTRL cores. In the examples below we will use the SPI memory controller core (SPIMCTRL) since it is attached to the SPI boot PROM on the GR-LEON4-ITX board. The first step in communicating with the SPI memory device is to allow the SPI Flash layer to detect the device:

```
grlib> spim flash detect

 Got manufacturer ID 0x20 and Device ID 0x2017
 No device match for READ ID instruction, trying RES instruction..
 Found matching device: ST/Numonyx M25P64

grlib>
```

Since the SPIMCTRL core maps the memory device into AMBA address space we can read the memory device using GRMON's *mem* command:

```
grlib> mem 0

        0  ffffffff  ffffffff  ffffffff  ffffffff    ................
       10  ffffffff  ffffffff  ffffffff  ffffffff    ................
       20  ffffffff  ffffffff  ffffffff  ffffffff    ................
       30  ffffffff  ffffffff  ffffffff  ffffffff    ................

grlib>
```

In the read out above the device is empty. We can now try to load a file to the device. First we give a shell command that lists the contents of the small S-REC file we will use for this example (do not issue the *shell cat* command on large or non-text files)

```
grlib> shell cat ~/tests/test_seq4-small

S0030000FC
S315000000000000000004040404080808080C0C0C0C4A
S315000000101010101014141414181818181C1C1C1C3A
S315000000202020202024242424282828282C2C2C2C2A
S315000000303030303034343434383838383C3C3C3C1A
S315000000404040404044444444484848484C4C4C4C0A
S315000000505050505054545454585858585C5C5C5CFA
S315000000606060606064646464686868686C6C6C6CEA
S315000000707070707074747474787878787C7C7C7CDA
```

… and so on. We can now download this file to the memory device:

```
grlib> spim flash load ~/tests/test_seq4-small

section:  at 0x0, size 256 bytes

entry point: 0x0
```

After downloading the file we can see that the contents has been written to the flash device:

```
grlib> mem 0

        0  00000000  04040404  08080808  0c0c0c0c    ................
       10  10101010  14141414  18181818  1c1c1c1c    ................
       20  20202020  24242424  28282828  2c2c2c2c        $$$$((((,,,,
       30  30303030  34343434  38383838  3c3c3c3c    000044448888<<<<

grlib>
```

GRMON also has support for dumping the contents of the memory device into a S-REC file, see the *GRMON User's Manual* for details.

Finally, we can erase the device, this should always be done before attempting to load data into the memory. Erasing is quite slow and will take a little over sixty seconds:

```
grlib> spim flash erase

grlib> mem 0 4

        0  ffffffff  ffffffff  ffffffff  ffffffff    ................

grlib>
```

When the device is erased, all bits will be set to '1'.

4.6 Interacting with I^{2}C devices

The *LEON4 ASIC* device provides three I2C interfaces, two master interfaces (*I2CM0* & *I2CM1*) and one slave interface (I2CS).

As a demonstration I^{2}C circuit, an on-board DS1672 Real-Time Clock circuit is connected on the board to the *I2CM0* interface of the ASIC.

The *I2CM1* and *I2CS* interfaces of the ASIC are connected to 4 pin 0.1” headers on the board, to allow an external circuit to be hooked-up. If required, 10kOhm pull-up resistors on the SCL and SDA signals can be installed if the appropriate jumpers JP9 and JP10 are installed.

One way to interact with multiple I^{2}C devices on the board is to connect one of the I2C masters to the I2C slave. This can be done by attaching J18:1 to J17:1 and J18:3 to J17:3. Pull-ups also need to be enabled (JP9:1-2,3-4 or JP10:1-2,3-4).

The following GRMON command will initialize the slave:

```
grlib> wmem 0xc0000600 0x50
grlib> wmem 0xc0000604 0x07
grlib> wmem 0xc0000614 0x99
```

The meaning of these write operations can be found by reading the I2C slave manual. The connections made above connected I2CM1 to the slave. GRMON enumerates I2CM1 as I2C core 2. To read data from the slave, issue:

```
grlib> i2c 2 read 0x50
```

Another way to interact with devices over I^{2}C is to communicate with the DS1672 real time clock (RTC). The RTC is connected to the bus if I2C M0, this master is enumerated as I^{2}C core 1 by GRMON. To detect any (7-bit addressable) devices on a bus the following command can be used:

```
grlib> i2c 1 scan

Scanning 7-bit address space on I2C bus:
 Detected I2C device at address 0x68
Scan of I2C bus completed. 1 device found

grlib>
```

The registers of the device can be read with:

```
grlib> i2c 1 read 0x68 0 5

 00:    ad      a9      29      b1
 04:    80

grlib>
```

The device can be written with:

```
grlib> i2c 1 write 0x68 0 0xab
grlib> i2c 1 read 0x68 0 5

 00:    ab      a9      29      b1
 04:    80

grlib>
```

Please see the *GRMON User's Manual* and the DS1672 data sheet for further details.

4.7 Other interfaces and operations

Please see the *GRMON User's Manual* for a description of the other debug drivers and capabilities provided by GRMON.

5 ADVANCED TOPICS

5.1 Building the Linux kernel

Overview

NOTE: *The Linux image programmed into the board SPI Flash boot PROM and the source code provided on the USB stick is for SnapGear Linux. This is an older Linux distribution that is no longer actively maintained by Aeroflex Gaisler. For users that want to do Linux kernel development, and for applications that require a newer user land, or are better off using BusyBox, it is recommended to start from Aeroflex Gaisler's newer solution built around Linux, named LinuxBuild. Packages are available from* http://www.gaisler.com*. The remained of the text below is applicable to the older SnapGear Linux distribution.*

Aeroflex Gaisler provides a Linux distribution named SnapGear Linux. A release of SnapGear Linux has been included on the first partition of the USB stick delivered with the board (software/Linux contains the distribution and *software/toolchains/Linux* contains the toolchain). SnapGear Linux can also be downloaded from http://www.gaisler.com

To be able to easily create a Linux configuration to run on the GR-LEON4-ITX board, SnapGear Linux includes three template configurations that can be selected to quickly compile a new Linux configuration:

Configuration name	Description
gr_l4itx_video	Main console is DVI video. Mounts root filesystem from second partition on USB Flash stick.
gr_l4itx_serial	No video support, main console is serial terminal. Mounts root filesystem from second partition on USB Flash stick.
gr_l4itx_busybox	No video support, main console is serial terminal. Root filesystem is a memory image containing a Busybox system, does not mount USB Flash stick.

Table 5-1: SnapGear template configurations

To be able to easily create a Linux configuration to run on the GR-LEON4-ITX board, SnapGear Linux includes three template configurations that can be selected to quickly compile a new Linux configuration.

First extract the SnapGear distribution:

```
jan@jan:~/Linux$ tar jxf snapgear-2.6-p41.tar.bz2
```

Enter the SnapGear directory and issue the command *make xconfig*. In the menu system click *Template Configurations* and select the wanted configuration in the new window, also check the box below the selection, as shown in Figure 5-1.

After the selection has been made, click the *Main Menu* button and in the remaining window click *Save and Exit*.

The configuration of the SnapGear system and Linux kernel have now been updated to predefined values. The system can now be compiled by issuing *make* at the system prompt.

The updated configuration can also be tailored as for normal SnapGear configurations. For further information on SnapGear please see the *SnapGear Linux for LEON* manual.

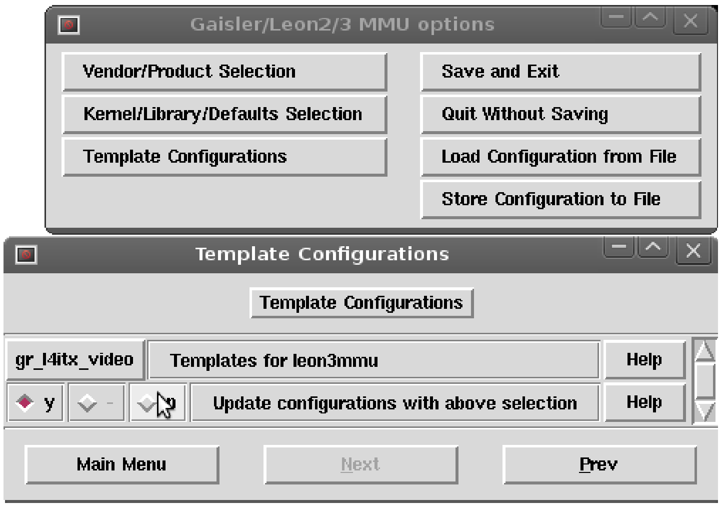

Figure 5-1: Selecting a SnapGear template configuration

Downloading an image with GRMON

After the new image has been compiled it can be downloaded to the board using GRMON. In the transcript below we connect to the board using the EDCL, the flag *-nb* must be given to GRMON in order to not break on page faults, the *-u* flag is also given in order to see the serial console in GRMON:

```
jan@jan:~/Linux/snapgear-2.6-p41$ grmon -eth -ip 192.168.0.54 -nb -u

 GRMON LEON debug monitor v1.1.39 professional version
 Copyright (C) 2004-2008 Aeroflex Gaisler - all rights reserved.
 For latest updates, go to http://www.gaisler.com/
 Comments or bug-reports to support@gaisler.com
 ethernet startup. Found AHB 1 to AHB 0 bridge
 Device ID: : 0x102
 GRLIB build version: 3508
 initialising .....................................
 detected frequency: 100 MHz
 Component                             Vendor
 LEON4 SPARC V8 Processor              Gaisler Research
 LEON4 SPARC V8 Processor              Gaisler Research
```

…if the Linux image will use video output we need to initialize the DVI transmitter:

```
grlib> i2c 3 dvi init_l4itx_dvi
 Transmitter was not set to Chrontel CH7301C (AS=0), changing..
 DVI transmitter set to Chrontel CH7301C (AS=0)

 Initializing CH7301 for LEON/GRLIB design..
 Initialization done..

grlib>
```

After this we can load the Linux image:

```
grlib> load images/image.dsu
section: .stage2 at 0x40000000, size 10240 bytes
section: .vmlinux at 0x40004000, size 2782144 bytes
total size: 2792384 bytes (79.0 Mbit/s)
read 6260 symbols
entry point: 0x40000000
grlib> run
Booting Linux
Booting Linux...
pkbase: 0xfc800000 pkend: 0xfcc00000 fixstart 0xfcfe4000

Debian GNU/Linux 4.0 gr-leon4-itx ttyS0

gr-leon4-itx login:
```

The above transcript loaded an image built from the the *gr_l4itx_video* configuration. In that case the boot messages are passed to the graphical console. The Linux boot takes some time and you may need to wait a minute before reaching the login prompt on the serial console. The video output will show the boot messages as the system starts up.

If we instead load an image built from the *gr_l4itx_serial* configuration, all output will be directed to the serial console:

```
grlib> load images/image.dsu
section: .stage2 at 0x40000000, size 10240 bytes
section: .vmlinux at 0x40004000, size 2642880 bytes
total size: 2653120 bytes (79.1 Mbit/s)
read 6159 symbols
entry point: 0x40000000
grlib> run
Booting Linux
Booting Linux...
PROMLIB: Sun Boot Prom Version 0 Revision 0
Linux version 2.6.21.1 (jan@jan) (gcc version 3.4.4) #17 SMP Tue Mar 16 15:28:21 CET
2010
ARCH: LEON
TYPE: Leon2/3 System-on-a-Chip
Ethernet address: 0:0:0:0:0:0
CACHE: 2-way associative cache, set size 4k
Boot time fixup v1.6. 4/Mar/98 Jakub Jelinek (jj@ultra.linux.cz). Patching kernel
for srmmu[Leon2]/iommu
64MB HIGHMEM available.
Nocache: 0xfc000000-0xfc400000, 1024 pages [128-1280]
node 2: /cpu00 (type:cpu) (props:.node device_type mid mmu-nctx clock-frequency
uart1_baud uart2_baud )
node 3: /a: (type:serial) (props:.node device_type name )
node 4: /ambapp0 (type:ambapp) (props:.node device_type name )
node 5: /cpu01 (type:cpu) (props:.node device_type mid clock-frequency )
PROM: Built device tree from rootnode 1 with 1813 bytes of memory.
DEBUG: psr.impl = 0xf  fsr.vers = 0x7
Built 1 zonelists.  Total pages: 64338
Kernel command line: console=ttyS0,38400 root=8:2 rootdelay=10 init=/sbin/init
PID hash table entries: 1024 (order: 10, 4096 bytes)
Todo: init master_l10_counter
```

```
Attaching grlib apbuart serial drivers (clk:100hz):
Console: colour dummy device 80x25
Dentry cache hash table entries: 32768 (order: 5, 131072 bytes)
Inode-cache hash table entries: 16384 (order: 4, 65536 bytes)
pkbase: 0xfc800000 pkend: 0xfcc00000 fixstart 0xfcfe4000
Memory:  252864k/262144k  available  (2120k  kernel  code,  9116k  reserved,  292k  data,
160k init, 65536k highmem)
Mount-cache hash table entries: 512
Entering SMP Mode...
0:(2:2) cpus mpirq at 0xc0800110
Starting CPU 1 : (irqmp: 0xc0800110)
DEBUG: psr.impl = 0xf  fsr.vers = 0x7
Started CPU 1
Brought up 2 CPUs
Total of 2 processors activated (399.76 BogoMIPS).
migration_cost=10000
NET: Registered protocol family 16
Found GRPCI controller - ahb mem,io: 0x80000000, 0xfff20000 - apb 0xc0100800 - irq:
25
Assigning PCI BARs.
SCSI subsystem initialized
usbcore: registered new interface driver usbfs
usbcore: registered new interface driver hub
usbcore: registered new device driver usb
NET: Registered protocol family 2
IP route cache hash table entries: 2048 (order: 1, 8192 bytes)
TCP established hash table entries: 8192 (order: 4, 98304 bytes)
TCP bind hash table entries: 8192 (order: 4, 65536 bytes)
TCP: Hash tables configured (established 8192 bind 8192)
TCP reno registered
leon: power management initialized
highmem bounce pool size: 64 pages
Installing knfsd (copyright (C) 1996 okir@monad.swb.de).
io scheduler noop registered
io scheduler cfq registered (default)
grlib apbuart: 2 serial driver(s) at [0xc0000100(irq 2),0xc0000200(irq 3)]
grlib apbuart: system frequency: 100000 khz, baud rates: 38400 38400
ttyS0 at MMIO 0xc0000100 (irq = 2) is a Leon
Testing fifo size for UART port 0: got 8 bytes.
ttyS1 at MMIO 0xc0000200 (irq = 3) is a Leon
Testing fifo size for UART port 1: got 8 bytes.
RAMDISK driver initialized: 16 RAM disks of 4096K size 1024 blocksize
loop: loaded (max 8 devices)
Probing GRETH Ethernet Core at 0xc0100100
                                            Detected National Semiconductor DP83848
Revision 0
10/100 GRETH Ethermac at [0xc0100100] irq 12. Running 100 Mbps full duplex
Probing GRETH Ethernet Core at 0xc0100200
Detected National Semiconductor DP83848 Revision 0
10/100 GRETH Ethermac at [0xc0100200] irq 13. Running 100 Mbps full duplex
usbmon: debugfs is not available
grusbhc-ehci grusbhc-ehci.0: Gaisler Research EHCI Host Controller
grusbhc-ehci grusbhc-ehci.0: new USB bus registered, assigned bus number 1
grusbhc-ehci grusbhc-ehci.0: irq 6, io base 0xc0100300
grusbhc-ehci grusbhc-ehci.0: USB 2.0 started, EHCI 1.00, driver 10 Dec 2004
usb usb1: configuration #1 chosen from 1 choice
hub 1-0:1.0: USB hub found
hub 1-0:1.0: 2 ports detected
USB Universal Host Controller Interface driver v3.0
grusbhc-uhci grusbhc-uhci.0: Gaisler Research UHCI Host Controller
grusbhc-uhci grusbhc-uhci.0: new USB bus registered, assigned bus number 2
grusbhc-uhci grusbhc-uhci.0: irq 7, io base 0xfff00200
usb usb2: configuration #1 chosen from 1 choice
```

```
hub 2-0:1.0: USB hub found
hub 2-0:1.0: 2 ports detected
Initializing USB Mass Storage driver...
usb 1-2: new high speed USB device using grusbhc-ehci and address 2
usb 1-2: configuration #1 chosen from 1 choice
scsi0 : SCSI emulation for USB Mass Storage devices
usbcore: registered new interface driver usb-storage
USB Mass Storage support registered.
usbcore: registered new interface driver usbhid
drivers/usb/input/hid-core.c: v2.6:USB HID core driver
i2c /dev entries driver
TCP cubic registered
NET: Registered protocol family 1
NET: Registered protocol family 17
drivers/rtc/hctosys.c: unable to open rtc device (rtc0)
Waiting 10sec before mounting root device...
scsi 0:0:0:0: Direct-Access     Kingston DataTraveler G2  PMAP PQ: 0 ANSI: 0 CCS
SCSI device sda: 15679488 512-byte hdwr sectors (8028 MB)
sda: Write Protect is off
sda: assuming drive cache: write through
SCSI device sda: 15679488 512-byte hdwr sectors (8028 MB)
sda: Write Protect is off
sda: assuming drive cache: write through
 sda: sda1 sda2
sd 0:0:0:0: Attached scsi removable disk sda
sd 0:0:0:0: Attached scsi generic sg0 type 0
kjournald starting.  Commit interval 5 seconds
EXT3-fs: mounted filesystem with ordered data mode.
VFS: Mounted root (ext3 filesystem) readonly.
Freeing unused kernel memory: 160k freed
INIT: version 2.86 booting
Activating swap...done.
EXT3 FS on sda2, internal journal
Setting the system clock..
Cannot access the Hardware Clock via any known method.
Use the --debug option to see the details of our search for an access method.
Cleaning up ifupdown....
Loading device-mapper support.
Checking file systems...fsck 1.40-WIP (14-Nov-2006)
done.
Setting kernel variables...done.
Mounting local filesystems...done.
Activating swapfile swap...done.
Setting up networking....
Configuring network interfaces...Internet Systems Consortium DHCP Client V3.0.4
Copyright 2004-2006 Internet Systems Consortium.
All rights reserved.
For info, please visit http://www.isc.org/sw/dhcp/

Listening on LPF/eth0/00:00:7a:cc:43:12
Sending on   LPF/eth0/00:00:7a:cc:43:12
Sending on   Socket/fallback
DHCPREQUEST on eth0 to 255.255.255.255 port 67
DHCPACK from 192.168.0.1
bound to 192.168.0.114 -- renewal in 299105 seconds.
done.
INIT: Entering runlevel: 2
Starting system log daemon: syslogd.
Starting kernel log daemon: klogd.
Starting system message bus: dbus.
Starting mouse interface server: gpm/etc/rc2.d/S20gpm: line 65: /dev/input/mice: No
such device
/etc/rc2.d/S20gpm: line 65: /dev/input/mice: No such device
```

```
/etc/rc2.d/S20gpm: line 65: /dev/input/mice: No such device
.
* Not starting internet superserver: no services enabled.
Starting periodic command scheduler: crond.

Debian GNU/Linux 4.0 gr-leon4-itx ttyS0

gr-leon4-itx login: user
Password:
Last login: Thu Jan  1 01:03:40 1970 on ttyS0
Linux gr-leon4-itx 2.6.21.1 #17 SMP Tue Mar 16 15:28:21 CET 2010 sparc

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
user@gr-leon4-itx:~$ echo "Linux input via GRMON"
Linux input via GRMON
user@gr-leon4-itx:~$
```

Finally, we load the *gr_l4itx_busybox* configuration:

```
grlib> run
Booting Linux
Booting Linux...
PROMLIB: Sun Boot Prom Version 0 Revision 0
Linux version 2.6.21.1 (jan@jan) (gcc version 3.4.4) #18 SMP Tue Mar 16 15:36:57 CET
2010
ARCH: LEON
TYPE: Leon2/3 System-on-a-Chip
Ethernet address: 0:0:0:0:0:0
CACHE: 2-way associative cache, set size 4k
Boot time fixup v1.6. 4/Mar/98 Jakub Jelinek (jj@ultra.linux.cz). Patching kernel
for srmmu[Leon2]/iommu
64MB HIGHMEM available.
Nocache: 0xfc000000-0xfc400000, 1024 pages [128-1280]
node 2: /cpu00 (type:cpu) (props:.node device_type mid mmu-nctx clock-frequency
uart1_baud uart2_baud )
node 3: /a: (type:serial) (props:.node device_type name )
node 4: /ambapp0 (type:ambapp) (props:.node device_type name )
node 5: /cpu01 (type:cpu) (props:.node device_type mid clock-frequency )
PROM: Built device tree from rootnode 1 with 1813 bytes of memory.
DEBUG: psr.impl = 0xf  fsr.vers = 0x7
Built 1 zonelists.  Total pages: 63934
Kernel command line: console=ttyS0,38400 root=8:2 rootdelay=10 rdinit=/sbin/init
PID hash table entries: 1024 (order: 10, 4096 bytes)
Todo: init master_l10_counter
Attaching grlib apbuart serial drivers (clk:100hz):
Console: colour dummy device 80x25
Dentry cache hash table entries: 32768 (order: 5, 131072 bytes)
Inode-cache hash table entries: 16384 (order: 4, 65536 bytes)
pkbase: 0xfc800000 pkend: 0xfcc00000 fixstart 0xfcfe4000
Memory: 251328k/262144k available (2120k kernel code, 10728k reserved, 292k data,
1776k init, 65536k highmem)
Mount-cache hash table entries: 512
Entering SMP Mode...
0:(2:2) cpus mpirq at 0xc0800110
Starting CPU 1 : (irqmp: 0xc0800110)
DEBUG: psr.impl = 0xf  fsr.vers = 0x7
Started CPU 1
```

```
Brought up 2 CPUs
Total of 2 processors activated (399.36 BogoMIPS).
migration_cost=10000
NET: Registered protocol family 16
Found GRPCI controller - ahb mem,io: 0x80000000, 0xfff20000 - apb 0xc0100800 - irq:
25
Assigning PCI BARs.
SCSI subsystem initialized
usbcore: registered new interface driver usbfs
usbcore: registered new interface driver hub
usbcore: registered new device driver usb
NET: Registered protocol family 2
IP route cache hash table entries: 2048 (order: 1, 8192 bytes)
TCP established hash table entries: 8192 (order: 4, 98304 bytes)
TCP bind hash table entries: 8192 (order: 4, 65536 bytes)
TCP: Hash tables configured (established 8192 bind 8192)
TCP reno registered
leon: power management initialized
highmem bounce pool size: 64 pages
Installing knfsd (copyright (C) 1996 okir@monad.swb.de).
io scheduler noop registered
io scheduler cfq registered (default)
grlib apbuart: 2 serial driver(s) at [0xc0000100(irq 2),0xc0000200(irq 3)]
grlib apbuart: system frequency: 100000 khz, baud rates: 38400 38400
ttyS0 at MMIO 0xc0000100 (irq = 2) is a Leon
Testing fifo size for UART port 0: got 8 bytes.
ttyS1 at MMIO 0xc0000200 (irq = 3) is a Leon
Testing fifo size for UART port 1: got 8 bytes.
RAMDISK driver initialized: 16 RAM disks of 4096K size 1024 blocksize
loop: loaded (max 8 devices)
Probing GRETH Ethernet Core at 0xc0100100
Detected National Semiconductor DP83848 Revision 0
10/100 GRETH Ethermac at [0xc0100100] irq 12. Running 100 Mbps full duplex
Probing GRETH Ethernet Core at 0xc0100200
Detected National Semiconductor DP83848 Revision 0
10/100 GRETH Ethermac at [0xc0100200] irq 13. Running 100 Mbps full duplex
usbmon: debugfs is not available
grusbhc-ehci grusbhc-ehci.0: Gaisler Research EHCI Host Controller
grusbhc-ehci grusbhc-ehci.0: new USB bus registered, assigned bus number 1
grusbhc-ehci grusbhc-ehci.0: irq 6, io base 0xc0100300
grusbhc-ehci grusbhc-ehci.0: USB 2.0 started, EHCI 1.00, driver 10 Dec 2004
usb usb1: configuration #1 chosen from 1 choice
hub 1-0:1.0: USB hub found
hub 1-0:1.0: 2 ports detected
USB Universal Host Controller Interface driver v3.0
grusbhc-uhci grusbhc-uhci.0: Gaisler Research UHCI Host Controller
grusbhc-uhci grusbhc-uhci.0: new USB bus registered, assigned bus number 2
grusbhc-uhci grusbhc-uhci.0: irq 7, io base 0xfff00200
usb usb2: configuration #1 chosen from 1 choice
hub 2-0:1.0: USB hub found
hub 2-0:1.0: 2 ports detected
Initializing USB Mass Storage driver...
usbcore: registered new interface driver usb-storage
USB Mass Storage support registered.
usbcore: registered new interface driver usbhid
drivers/usb/input/hid-core.c: v2.6:USB HID core driver
i2c /dev entries driver
TCP cubic registered
NET: Registered protocol family 1
NET: Registered protocol family 17
drivers/rtc/hctosys.c: unable to open rtc device (rtc0)
Freeing unused kernel memory: 1776k freed
init started: BusyBox v1.8.2 (2010-03-16 15:33:25 CET)
```

```
starting pid 22, tty '': '/etc/init.d/rcS'
starting pid 33, tty '': '/bin/sh'
/ # echo "hello world"
hello world
/ # ls
bin       etc       init      linuxrc  proc      sys       usr
dev       home      lib       mnt      sbin      tmp       var
/ #
```

Note that the last configuration does not mount the root filesystem from the USB stick.

5.2 Creating a boot PROM

Overview

Creating a boot PROM allows the system to boot software after power-up without the need to connect with GRMON. There are several boot loaders available for LEON/GRLIB systems. This document contains descriptions on how to use two of them, MKPROM2 and U-boot, with the GR-LEON4-ITX board.

MKPROM2

Please see the MKPROM2 documentation for a general description of the application. This sections deals with specifics of the GR-LEON4-ITX board. The MKPROM2 package is included on the USB Flash stick in the directory *software/bootloaders/mkprom2* but it is preferable to download the latest version from http://www.gaisler.com.

MKPROM2 does not include support for initializing the DVI transmitter. In order to do this MKPROM can be instructed to include software provided by the user. The data package included with the board contains the file *gr-l4itx-pack/mkprom2/bdinit.c* that contains code for initializing the DVI transmitter via I^{2}C. To compile bdinit.c so that it can be included in the boot ROM issue the command:

```
sparc-elf-gcc -Wall -c -g -O2 bdinit.c
```

Add the switch *-DBPP24* if you will use 24-bit color and add *-DDVI* if you want to use digital DVI output (to autodetect the type of screen connected via I^{2}C and select the correct initialisation parameters is left as an exercise for the reader). The command line options for MKPROM2 to be used with the GR-LEON4-ITX are:

MKPROM2 included on USB Flash stick:

Note: *The MKPROM2 version included on the Flash stick does not support booting SMP Linux. Please see text below on more recent MKPROM2 versions for SMP booting.*

```
mkprom2 -v -freq 100 -stack 0x4ffffff0 -pnp 0xffeff800 -ddr2spa_cfg1 0x96a08616
-ddr2spa_cfg3 0x13650000 -ddr2spa_cfg4 0x0000017f -gpt 0xc0000300 -irqmp 0xc0800100
-uart 0xc0000100 -dsustart 0xd0000000 -dsutrace -bdinit -nomsg
```

However, at the time of writing MKPROM2 contains some hard coded values for addresses in the system that makes it unsuitable for creating boot ROMs for the GR-LEON4-ITX board. A workaround is to skip much of the built-in initialization provided by MKPROM and instead perform the initialisation with the *bdinit(..)* calls. The file *gr-l4itx-pack/mkprom2/bdinit2.c* contains initialisation code for the DDR2 memory controller, APBUART and timer unit.

In order to build a boot ROM for a system that will use video output, first compile bdinit2.c:

```
jan@jan:~/Linux$ sparc-elf-gcc -Wall -c -g -O2 -DDVI -o bdinit.o bdinit2.c
```

After this we can create an image using the SnapGear Linux kernel as input:

```
jan@jan:~/Linux$ /opt/mkprom2/mkprom2 -v -freq 100 -stack 0x4ffffff0 -pnp 0xffeff800
-irqmp  0xc0800100  -dsustart  0xd0000000  -dsutrace  -bdinit  -nomsg  snapgear-2.6-
p41/images/image.dsu

LEON2/3/ERC32 MKPROM prom builder for BCC, ECOS, RTEMS and ThreadX v2.0.25
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phead0:  type:  1,  off:  65536,  vaddr:  40000000,  paddr:  40000000,  fsize:  2674944,
msize: 2833212
phead1: type: 6474e551, off: 0, vaddr: 0, paddr: 0, fsize: 0, msize: 0
section: .stage2 at 0x40000000, size 10240 bytes
Uncoded stream length: 10240 bytes
Coded stream length: 3374 bytes
Compression Ratio: 3.035
section: .vmlinux at 0x40004000, size 2658560 bytes
Uncoded stream length: 2658560 bytes
Coded stream length: 1562710 bytes
Compression Ratio: 1.701

creating LEON3 boot prom: prom.out
Searching for compiler to use (sparc-elf, sparc-rtems or sparc-linux):
sparc-elf-gcc (GCC) 3.4.4
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This is free software; see the source for copying conditions.  There is NO
warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.


sparc-elf-gcc      -O2      -g      -N      -T/opt/mkprom2/linkprom      -Ttext=0x0
/opt/mkprom2/promcore.o       /opt/mkprom2/promcrt0.o       /opt/mkprom2/promload.o
/opt/mkprom2/promdecomp.o                   -nostdlib       /opt/mkprom2/prominit.o
/opt/mkprom2/prominit_leon3.o  /opt/mkprom2/prombdinit.o     dump.s   bdinit.o     -o
prom.out
multidir:
jan@jan:~/Linux$
```

MKPROM2 available from gaisler.com:

Generate image with SMP Linux kernel as input:

```
mkprom2  -memc  0xFFE00100  -freq  100  -nopnp  -ddr2spa_cfg1  0xf6a08616  -ddr2spa_cfg3
0x13650000   -ddr2spa_cfg4   0x0000017f   -gpt   0xc0000300   -irqmp   0xc0800100   -uart
0xc0000100  -dsustart  0xd0000000  -dsutrace  -baud  38400  -mp  -mpentry  2  0x40000000
0x40000000  -mpstack  2  0x4ffffff0  0x4ffffff0  -nomsg  -o  output.prom  <linux  kernel
image name>.ram
```

Programming PROM image to SPI Flash:

The SPI Flash memory device can now be programmed with the PROM contents in the prom.out file generated by MKPROM2 (it is recommended to use the Ethernet debug link when programming the flash), start GRMON and issue the following commands:

```
grlib> spim flash detect

 Got manufacturer ID 0x20 and Device ID 0x2017
 No device match for READ ID instruction, trying RES instruction..
 Found matching device: ST/Numonyx M25P64

grlib> spim flash load prom.out
section: .text at 0x0, size 1575824 bytes
section: .data at 0x180b90, size 32 bytes
total size: 1575856 bytes (119.3 kbit/s)
```

```
read 131 symbols
entry point: 0x00000000
```

The flash contents can now also be verified, either by *spim flash verify prom.out* or by the faster *verify prom.out*:

```
grlib> verify prom.out
section: .text at 0x0, size 1575824 bytes
section: .data at 0x180b90, size 32 bytes
total size: 1575856 bytes (12.0 Mbit/s)
entry point: 0x00000000
grlib>
```

The PROM has now been successfully programmed. The software located in PROM can now be booted by power cycling the board or by pushing the reset button.

U-boot

Note: *U-boot currently only supports boot Linux images created with the SnapGear distribution. If the more recent LinuxBuild Linux package is used then MKPROM2 must be used to generate the PROM image.*

U-Boot (Das Universal Boot loader) is boot loader for embedded systems developed by http://www.denx.de and a port exists for SPARC/LEON. The LEON U-Boot can boot RTEMS, VxWorks and Linux 2.6. Building the u-boot boot loader can be done with the sparc-elf-gcc (BCC) crosscompiler.

The GR-LEON4-ITX data package contains a pre-built U-Boot image with a configuration suitable for the board. The image is available in different formats in the directory *gr-l4itx-pack/u-boot/prebuilt* this directory also contains a pre-built version of the *mkimage* tool. The source for U-boot is on the USB Flash stick in the directory *software/bootloaders/u-boot*. To re-build u-boot, enter the U-boot source directory and issue the command *make gr_leon4_itx_config* followed by *make*.

To load the image onto the board, issue the following commands:

```
grlib> spim flash detect

 Got manufacturer ID 0x20 and Device ID 0x2017
 No device match for READ ID instruction, trying RES instruction..
 Found matching device: ST/Numonyx M25P64

grlib> spim flash erase
grlib> spim flash load u-boot
section: .text at 0x0, size 208150 bytes
section: .u_boot_cmd at 0x32d18, size 1272 bytes
section: .data at 0x33210, size 34816 bytes
section: .got at 0x3ba10, size 4688 bytes
total size: 248926 bytes (116.9 kbit/s)
read 736 symbols
entry point: 0x00000000
grlib> verify u-boot
section: .text at 0x0, size 208150 bytes
section: .u_boot_cmd at 0x32d18, size 1272 bytes
section: .data at 0x33210, size 34816 bytes
section: .got at 0x3ba10, size 4688 bytes
total size: 248926 bytes (10.6 Mbit/s)
entry point: 0x00000000
grlib>
```

Next we need to build a Linux kernel image that U-boot can handle. U-Boot needs a header to know how to interpret the binary images. The images support compression and CRC verifying. To create an image, the *mkimage* tool must be in the system path. The Linux kernel has a prepared build target for generating u-boot images (uImage):

```
jan@jan:~/Linux/snapgear-2.6-p41$ cd linux-2.6.21.1/
jan@jan:~/Linux/snapgear-2.6-p41/linux-2.6.21.1$ make ARCH=sparc \
                                              CROSS_COMPILE=sparc-linux- uImage
  CHK     include/linux/version.h
  CHK     include/linux/utsrelease.h
```

… removed output ...

```
sparc-linux-ld   -Tdata   0x00040000   -r   -b   binary   arch/sparc/boot/uImage   -o
arch/sparc/boot/uImage.o
  Image arch/sparc/boot/uImage is ready
jan@jan:~/Linux/snapgear-2.6-p41/linux-2.6.21.1$
```

In order to interact with the pre-built version of U-boot the board must be connected to a monitor and a USB keyboard. The uImage created above should be placed in the root of a TFTP sever and a Ethernet cable should be connected to the GR-LEON4-ITX board's second (top) Ethernet port.

After the necessary preparations have been made reset the board and press a key on the USB keyboard to stop the U-boot boot process. When presented with the U-boot prompt issue the following commands (see the U-boot documentation for more commands and the meaning of the commands below):

```
=> setenv severip <ip address of tftp server>
=> saveenv
=> run getkernel
=> sf probe
=> sf erase 400000 200000
=> sf write 40200000 400000 $(filesize)
```

To see information about the downloaded image issue the command:

```
=> iminfo
```

It is also possible to update the u-boot image using GRMON. First interact with U-boot and issue the commands:

```
=> sf probe 0
=> sf erase 400000 200000
```

Then the Linux image can be built with:

```
make ARCH=sparc CROSS_COMPILE=sparc-linux- UIMAGE_FLASHADDR=0x00400000 uImage
```

and loaded in GRMON via (note the .o suffix):

```
grmon> spim flash load arch/sparc/boot/uImage.o
```

6 TROUBLESHOOTING AND FREQUENCY ASKED QUESTIONS

6.1 General

The performance of the system is less compared to what is advertised for LEON4

The advertised LEON4 performance figures typically come from systems that include a Level-2 cache core. The GR-LEON4-ITX board and LEON4-ASIC-DEMO device were constructed using a pre-release version of the LEON4 processor and the L2 cache core was not available at this time. If you need to benchmark a system with a Level-2 cache, please contact Aeroflex Gaisler.

I lost the contents of the USB Flash stick

Contact Aeroflex Gaisler for a possible download of the original stick contents, or a replacement stick.

How do I restore the original PROM contents?

A copy of the original PROM contents is available in the GR-LEON4-ITX data package under the directory *gr-l4itx-pack/prom*. The file *l4itx_prom.srec* can be written to the SPI boot PROM using the GRMON commands: *spim flash detect*, *spim flash erase*, *spim flash load l4itx_prom.srec*.

GRMON reports a system frequency of 100 MHz, should it not be 200 MHz?

The bus with most of the peripherals (AHB bus 1) runs at 100 MHz and the bus with the LEON4 processors (AHB bus 0) runs at 200 MHz. GRMON connects bus 1 and also finds the timer unit there, therefore GRMON reports the system frequency as 100 MHz, the processor cores still run at 200 MHz.

6.2 Interfaces

Software freezes when initializing the Ethernet Interface

Software that relies on the MDIO interrupt for Ethernet PHY initialization may time out when bringing up the Ethernet interface. This is an issue with some version of the Linux kernel included in the SnapGear GNU/Linux distribution provided by Aeroflex Gaisler. A general quick fix is to attach a network cable to each Ethernet port that is being initialized. The long term fix is to contact the software vendor and ask for an update.

I have problem X when using the USB Debug Communication Link

The USB Debug Communication Link has a bug that leads to repeated accesses. This is a problem when accessing register interfaces that are FIFOs, that is the interfaces are affected by being read or written more than once with the same value. Therefore the USB Debug communication link must not be used when interacting with a UART (for instance when using the -u flag to GRMON) or using the SPIMCTRL or SPICTRL cores.

Also, jumper J10 17-18 (GPIO 43) must be installed at power-on for the USB DCL interface to work.

The system freezes when using it together with my PCI device

The GRPCI core's PCI target interface included in the design has a bug that causes it to perform bursts of infinite length if a PCI master performs a burst of eight or more words.

There is no known workaround for this issue and the LEON4-ASIC-DEMO device cannot be used in a system where it will be accessed by a master performing bursts over eight words in length.

I²C communication does not work

Please make sure that the bus has pull-ups (see the GR-LEON4-ITX Board User Manual for how to enable pull-ups).

My USB disk is not detected / does not work

The board may not be able to provide enough power for drives connected via USB. Try connecting the device via a USB hub that has a power source.

How do I change the Ethernet Debug Link IP address in the delivered system?

The system is delivered pre-programmed with the bootloader U-boot. After system reset, U-boot will initialize the system, which includes setting the Ethernet Debug Communication Link's (EDCL) IP address. The address used by U-boot can be changed by attaching a USB keyboard and pressing any key during the first seconds of system boot. U-boot will then interrupt the boot process and show a prompt.

The IP address that U-boot will assign to the EDCL is stored in the variable *greth_edcl_ip0*. To show the systems variables, issue the command:

```
=> printenv
```

To change the EDCL IP address to 172.16.0.24, issue the command:

```
=> setenv greth_edcl_ip0 172.16.0.24
```

To preserve the value after system reset the variable needs to be saved to SPI flash, this is done with the command:

```
=> saveenv
```

It is also possible to change the EDCL IP address via GRMON, using the *edcl* command. However, this will not affect the address used by U-boot after system reset.

6.3 Additional support

For customers with a support contract, or for issues where the board or device seem faulty, please contact support@gaisler.com.